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Dikici, Mursel

Monterey, California. Naval Postgraduate School

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Mursel Dikici

NAVAL POSTGRADUATE SCHOOL
Monterey, California
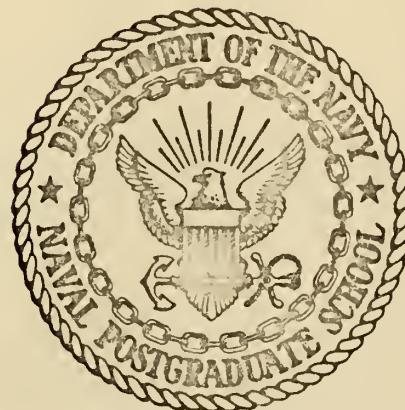
THESIS

THE EFFECTS OF INCREASED INFORMATION PROCESSING

ON SINUS ARRHYTHMIA AND ANXIETY LEVEL

by

Mursel Dikici

Thesis Advisor: D. E. Neil

September 1973

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The Effects of Increased Information Processing

on Sinus Arrhythmia and Anxiety Level

by

Mursel Dikici
Lieutenant (junior grade), Turkish Navy
B.S., Naval Postgraduate School, 1973

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requirements for the degree of

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ABSTRACT

This experiment investigated the effect of increased information processing on sinus arrhythmia and anxiety level. Results of a one-way analysis of variance indicated that increased information processing had affected sinus arrhythmia and had no affect on anxiety level. Simple linear correlation analysis was performed to determine the relationships between sinus arrhythmia, anxiety level and information processing rate. An increase in information level was accompanied by a decrease in sinus arrhythmia and anxiety levels remained constant across information loads.

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I. <u>INTRODUCTION</u>

This experiment was designed to investigate the effect of increased information processing on sinus arrhythmia and anxiety level. A series of recent studies (Corday and Irving, 1961; Davies and Neilson, 1967; Douglas, 1972; Dreifs, 1966) have indicated that the average human heart rate is irregular. This change in heart rate is known as sinus arrhythmia. Sinus arrhythmia is considered normal particularly in youthful hearts and is no cause for concern. However, a considerable degree of sinus arrhythmia may be found in older persons with arteriosclerosis or coronary disease.

The manifest anxiety scale was originally constructed by Taylor (1951). The use of the anxiety scale was based on two assumptions. First, that variations in drive level of the individual is related to the level of internal anxiety or emotionality, and second, that the intensity of this anxiety could be ascertained by a paper and pencil test consisting of items describing what have been called overt or manifest symptoms of this state. The manifest anxiety test that was used during the experiment consisted of 109 items, 50 of the items were indicative of anxiety and the rest were considered as buffer items (Taylor, 1953).

Consistent with information theory, one bit of information is the amount of information required to make a decision between two equally likely alternatives. Two bits of information provides sufficient information to make a decision among four equally likely alternatives (Bell, 1953). The actual number of bits of information is found by taking the logarithm to the base 2 of the number of equally likely alternatives (Poock, 1967).

The present experiment increased the amount of information to be processed by using three levels. The first level was a resting state and presumably did not require any information processing. The remaining two levels required processing one and two bits respectively.

Therefore, the primary objective in the present study was to design an experiment that could investigate the effect of increased information processing on sinus arrhythmia and anxiety level.

II. <u>METHOD</u>

A. APPARATUS

A Beckman type RM Dynograph Recorder was used to monitor the electrocardiogram rate and heart beat. Both the electrocardiogram rate and heart beat were recorded simultaneously. A cardiotachometer coupler was used to calculate the electrocardiogram rate. The time increment between successive R waves was measured by the cardiotachometer and instantaneous heart beat rate was then calculated. A continuous plot of this rate was recorded on graph paper. The recorder was calibrated so that there was 30 millimeters between the 60 and 120 beats per minute with a chart speed of two millimeters per second. Six Beckman electrodes were positioned on the subjects chest in order to obtain the readings. (Two were for heart beat, two for electrocardiogram rate, and the remaining being the null electrodes.)

To present the different levels of information processing, a visual test similar to that of Poock (1967) was used. The subjects responded to numbers on a $2\frac{1}{4}$" x $1\frac{1}{2}$" transilluminated screen. The subjects responded to the numbers by pushing colored buttons that corresponded to the numbers presented. These buttons were located on a panel directly below the screen.

The one bit decision was generated by using the numbers 2 and 3 as the equally likely alternatives. The two bit decision was generated by using the numbers 1, 2, 3, and 4 as the equally likely alternatives. A probability randomizer was employed in order to display the numbers in

a completely random manner. This was accomplished by programming a random sequence of numbers into the machine and by designating a probability of fifty percent that the number would appear during its turn in the program sequence. Each subject used his index fingers of both hands for the one bit decision. That is, the index finger of his left hand was the number two and the index finger of his right hand was the number three. During the two bit decision each subject added the middle finger of both hands. Therefore, the middle finger of his left hand was number one, the index finger number two, the index finger of right hand number three, and the middle finger number four. The buttons on the response panel were placed so as to allow for the normal difference in length between the index and middle finger. The signals (100 signals at each level) were presented for eight minutes and the cumulative time between when the signal appeared and when the subject responded was recorded by the electronic counter.

B. TEST SITE AND SUBJECTS

The experiment was performed in the Man-Machine Systems Design Laboratory of the Naval Postgraduate School. Subjects were seated in a chair with the transilluminated screen and response panel in front of them on a table in the experiment booth. The experimenter stood in front of the RM Dynograph Recorder which was adjacent to the probability randomizer and signal sending panel.

The eight subjects were all male officer students from the Naval Postgraduate School. Their ages varied between 24 and 37.

C. PROCEDURE

After entering the laboratory, each subject was instructed to strip to the waist. The Beckman electrodes were then placed on his chest and he was seated in the booth. The instructions for the experiment were explained. Following the explanations, the experimenter calibrated the dynograph for each individual subject.

It was explained that the experiment would consist of three major parts. Part one would be five minutes of resting and taking the Biographical Inventory Test. Part two, which was two days after part one, would be eight minutes of observing and responding to the one bit information processing task (response to numerals 2 or 3 on the transilluminated screen) and taking the Biographical Inventory Test. Part three, which followed two days after part two, consisted of eight minutes of observing and responding to a two bit information processing task (response to the numerals 1, 2, 3, or 4 on the transilluminated screen) and again taking the Biographical Inventory Test.

The subjects were instructed to push the button corresponding to the number on the screen until the number disappeared. They were also instructed to push only one button at a time and to respond as quickly as possible. The numbers were presented in random order at each decision level, and the experimenter recorded the response times for each decision level. Upon conclusion of the third part of the experiment, experimenter explained, in general, the purpose and objectives of the experiment.

D.   REDUCTION OF DATA

After conclusion of the experimentation the following data had been obtained; 8 electrocardiogram rate traces, 8 cumulative response times for the one and two bit information levels, and 8 anxiety level scores for the rest, one bit and two bit levels.

The mean heart beat rate for each of the three parts was computed by counting the number of R waves during the last minute of the rest period and the final minute of each of the information processing parts. This sampling procedure was selected for analysis, because it was considered as a steady state of the heart. In other words, the subjects' heart had sufficient time to reach a pattern that reflected the effect of information processing.

The mean heart beat rate was used as the base line for computation of sinus arrhythmia. The measure of sinus arrhythmia was calculated in the same manner outlined by Bosper (1970) with the exception that each square millimeter of area was summed to obtain the sinus arrhythmia (see Figure 1). Periods for measurement of sinus arrhythmia corresponded to the measured heart beat periods. For the total experiment with all subjects included, there were 8 data points of sinus arrhythmia for the rest and each level of information processing. Namely, 8 data points for rest, 8 data points for 1 Bit, and 8 data points for 2 Bit information level.

The information processing rate for each of the subjects was computed by the following way. The average time to process each decision was obtained by dividing the cumulative reaction time by the number of decisions. For example, if it took 50 seconds to perform 100 one bit decisions, the information rate was 2 decisions per second. As a result, there were 2 values for 8 subjects or 16 data points, 8 for one bit and 8 for 2 bit information processing levels.

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The Biographical Inventory Tests were scored as explained by Taylor (1953) and 8 anxiety scores were obtained for each information processing levels.

1 minute, 72 BPM = # of R waves

80 BPM

72 BPM

Electrocardiogram Rate

64 BPM
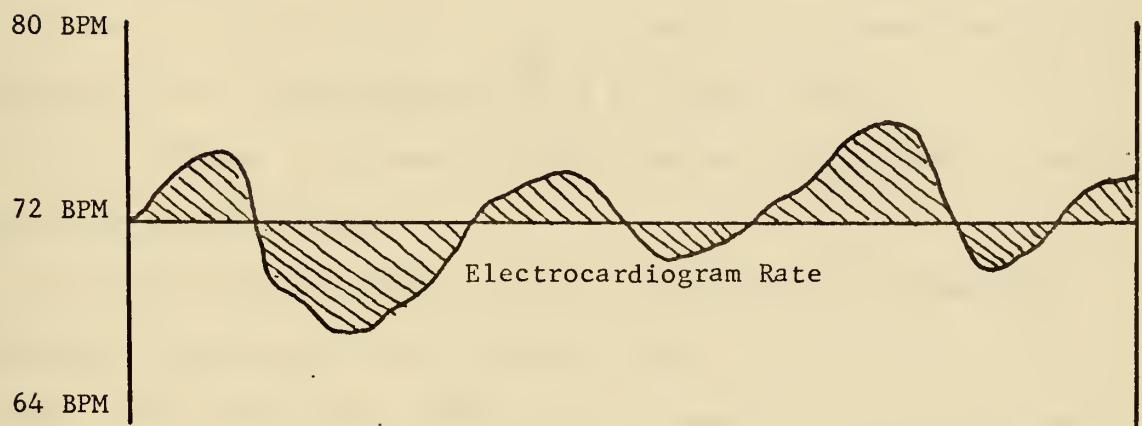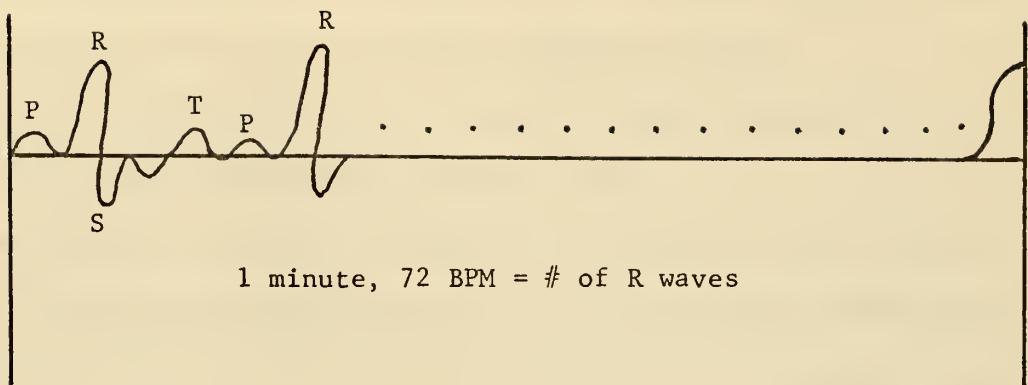
Figure 1. Shaded area represents Measure of Sinus Arrhythmia

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III.   STATISTICAL TESTS AND RESULTS

A one way analysis of variance design was used to compare sinus arrhythmia and information processing levels. This same design was used to compare anxiety level and information processing levels.

A one way analysis of variance was used to compare information processing rates and information processing levels.

A simple linear correlation analysis was performed at both one·bit and two bit information processing levels. All correlation combinations between sinus arrhythmia, anxiety level and information processing rates were considered.

Figure 2 shows the results in graphical form. The analysis of variance results, Tables I - III indicate:

1. An increase in information level resulted in a reduction in sinus arrhythmia (heart rate variability), (p less than .005).

2. An increase in information level resulted in no effect on anxiety level (p greater than .25).

3. An increase in information level resulted in an increase in information processing rate (p less than .001).

The correlation results, Tables IV - V, show that all correlation combinations between sinus arrhythmia, anxiety level and information processing rates are not significant at the one bit and two bit decision levels except the correlation coefficient of $r = 0.49$ was found between sinus arrhythmia and anxiety level at the one bit decision level.

Duncan Multiple Range Test results, Table VI, show that sinus arrhythmia is significantly reduced at each level.

Figure 2

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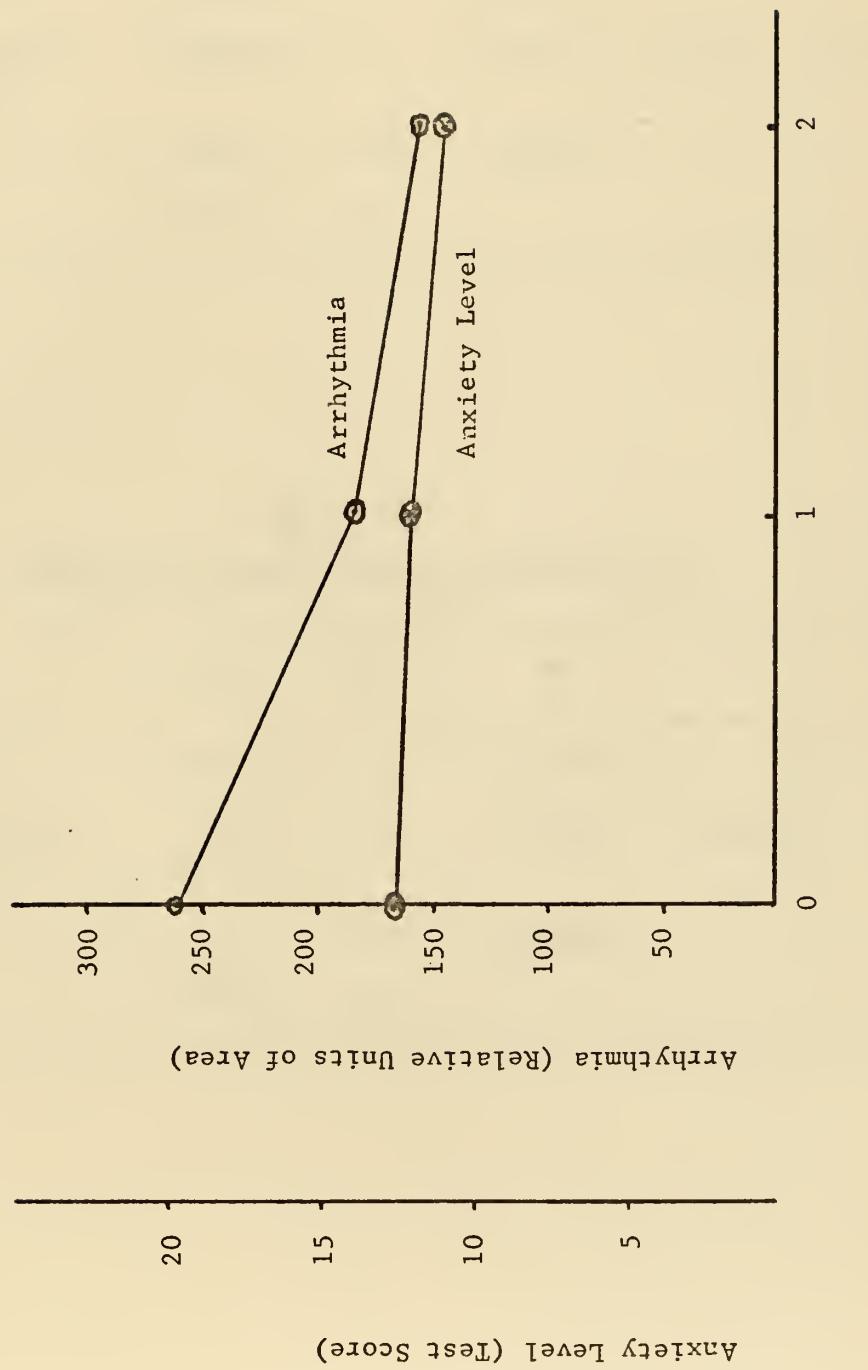
Table I

ANALYSIS OF VARIANCE MODEL ON SINUS ARRHYTHMIA

Sources	Ss	df	MS	F	p
Between Subjects	87750.48	7	12535.78		
Between Information Processing Levels	46788.59	2	23394.29	10.11	<0.005
Error	32406.77	14	2314.77		
TOTAL	166945.8	23			

Table II

ANALYSIS OF VARIANCE MODEL ON ANXIETY LEVEL

Sources	Ss	df	MS	F	p
Between Subjects	590.5	7	84.35714		
Between Information Processing Levels	6.08	2	3.0416	0.633	NS
Error	67.25	14	4.8035		
TOTAL	663.83	23			

Table III

ANALYSIS OF VARIANCE MODEL ON INFORMATION PROCESSING RATES

Sources	Ss	df	MS	F	p
Between Subjects	1.6846	7	0.2406		
Between Information Processing Levels	7.3712	1	7.3712	59.14	<0.001
Error	0.8724	7	0.1246		
TOTAL	9.9282	15			

Table IV

RESULTS OF SIMPLE LINEAR CORRELATION

ANALYSIS AT 1 BIT LEVEL

Dependent Variable	Independent Variable	Linear Correlation Coefficient (r)
Information Processing Rate	Arrhythmia	-0.1069
Information Processing Rate	Anxiety Level	-0.0359
Arrhythmia	Anxiety Level	0.4932

Table V

RESULTS OF SIMPLE LINEAR CORRELATION

ANALYSIS AT 2 BIT LEVEL

Dependent Variable	Independent Variable	Linear Correlation Coefficient (r)
Information Processing Rate	Arrhythmia	0.3210
Information Processing Rate	Anxiety Level	-0.1599
Arrhythmia	Anxiety Level	0.125

Table VI

RESULTS OF DUNCAN MULTIPLE RANGE TEST

ON SINUS ARRHYTHMIA

	2 Bit	1 Bit	Resting
Rank	1	2	3
Mean Value	154.625	173.75	256.375

At p equals 0.005 all levels were found to be significantly different.

IV. DISCUSSION

The results of this experiment supported the results obtained by
Douglas (1972), Bonsper (1970) and Kalsbeek (1968), i.e., that sinus
arrhythmia decreased as information processing increased. The area
between the average heart beat line and electrocardiogram rate curve would
seem to be an accurate measure of sinus arrhythmia. This measure of sinus
arrhythmia accounts for magnitude, frequency and duration of variations
in electrocardiogram rate.

Before the experiment, it was expected that there could be a relation-
ship between sinus arrhythmia and anxiety level. It was found, however,
that the anxiety level averages decreased slightly. The decrease was so
small that it was not statistically significant. A possible explanation
for the slight decrease may lie in the fact that two days between the
information processing levels could be such a short time that subjects
tried to give the same responses that they gave two days before or
information processing levels which were used for the experiment were
not high enough to give distinguishable anxiety to the subjects.

Anxiety level scores varied between 2 and 18. This range is not
the indication of anxiety according to Taylor (1953). The subjects that
have been chosen for the experiment were all eighth quarter students
and their QPRs were all above 3.00 with one exception. Therefore, it
might be worthwhile to perform further experimentation choosing the
subjects from different quarters with low and high QPR levels and using
higher information processing levels.

APPENDIX A

SUMMARY OF OBSERVED DATA

(Last Minute for Sinus Arrhythmia in Relative Area Units,
Anxiety Level Scores and Information Processing Rates)

Subject	Sinus Arrhythmia			Anxiety Level			Information Processing Rates	
	Rest	1 Bit	2 Bit	Rest	1 Bit	2 Bit	1 Bit	2 Bit
1	279	253	206	11	17	14	3.0012	4.4169
2	196	138	121	14	16	16	3.3534	4.8590
3	236	182	146	13	10	12	3.6968	4.3985
4	179	155	133	15	14	13	2.7571	3.2916
5	248	162	148	4	4	3	2.6680	4.5934
6	127	118	108	11	13	12	3.0506	4.5693
7	508	245	224	23	18	14	3.0012	4.8756
8	278	137	151	5	3	3	3.3244	4.6871

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    Department of Operations Research and
    Administrative Sciences (Code 55)
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6. Associate Professor G. K. Poock   1
    Department of Operations Research and
    Administrative Sciences (Code 55Pk)
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